

Is Optimal LES a Practical Approach to LES Modeling?

R. D. Moser, P. Zandonade and P. Vedula

Department of Theoretical and Applied Mechanics
University of Illinois at Urbana-Champaign
104 S. Wright St., Urbana IL, 61081
r-moser@uiuc.edu, 217-244-7728

The shortcomings of most current LES modeling techniques are well known. Two of the more serious are near-wall modeling and the ambiguities introduced by practical (i.e. low-order) numerical discretization. Optimal LES, in which stochastic estimation techniques are used to formally optimize the LES model, can in principle address these problems. The modeling procedure yields an approximation to the ideal LES evolution, which is guaranteed to reproduce the single-time statistics of the filtered turbulence, and to minimize the expected difference between the evolution of a filtered turbulence and the LES. Using direct numerical simulation (DNS) statistical data to perform the estimates, several such models have been formulated for different turbulent flows and different LES filter definitions. These models perform remarkably well. They also yield important insights into the required properties of good LES models. To make these models useful however, it is necessary to eliminate the need for detailed statistical data from DNS. When the small scales can be considered isotropic, this can be accomplished through a combination of Kolmogorov inertial range scaling, the quasi-normal approximation and a dynamic procedure, and the resulting model is as accurate as that based on DNS data. Near walls, a variety of other theoretical considerations significantly constrain the required statistics, and using this, a formulation requiring minimal empirical input is being devised. In this talk, we will examine the development of the optimal LES to date, as outlined above, and the prospects that this technique will be of value in developing practical LES models that address outstanding LES modeling problems.